REMARKS/ARGUMENTS

The Office Action mailed March 25, 2004 has been reviewed and carefully considered. Claims 1-2 and 4-9 have been amended. Claims 1-9 are pending in this application, with claims 1, 8, and 9 being the only independent claims. Reconsideration of the above-identified application, as herein amended and in view of the following remarks, is respectfully requested.

In the Office Action mailed March 25, 2004, claims 1, 2, and 7-9 stand rejected under 35 U.S.C. §102(e) as anticipated by U.S. Patent No. 6,424,153 (Liu).

Claims 3-6 stand rejected under 35 U.S.C. §103 as unpatentable over Liu in view of U.S. Patent No. 6,078,176 (McKinnon).

Before discussing the cited prior art and the Examiner's rejections of the claims in view of that art, a brief summary of the present invention is appropriate. The present invention relates to magnetic resonance imaging wherein magnetic resonance signals are generated and temporary magnetic gradient fields are used. The system includes three sets of coils including main coils 10 for generating a uniform magnetic field (see page 4, lines 15-16 of the specification), a number of gradient coils 11, 12 for superposing temporary gradients on the uniform magnetic field (page 4, lines 19, 21), and transmission and receiving coils 13, 16 for generating RF excitation pulses and for collecting magnetic resonance signals (page 4, lines 25-26). The temporary gradient field produced by the gradient coils provides spatial encoding of the magnetic resonance signals (page 4, lines 33-34). However, the temporary gradient fields are spatially non-linear and the non-linearities give rise to distortions in the image reconstructed from the magnetic resonance signals (page 1, lines 6-9). A correction unit 29 corrects the signal amplitude of the magnetic resonance signals based on the spatial non-linearities in the gradient fields produced by the gradient coils (page 6, lines 1-3).

The deviations of actually produced magnetic gradient field from the ideal gradient field can be calculated using the geometrical shape of the gradient coils and the time profile of an electric current pulse applied to the gradient coil (page 2, lines 30-32). The correction for non-linearities is derived from these calculated deviations (page 6, lines 21-24). Accordingly, the correction of the magnetic resonance signals according to the claimed invention is based on the spatial non-linearities of the magnetic field produced by the gradient coils.

Independent claims 1, 8, and 9 have each been amended to clarify that the step of correcting is based on the spatial non-linearities in the magnetic field strength of said temporary magnetic gradient fields. More specifically, independent claims 1, 8, and 9 now recite "correcting said signal amplitudes of said spatially encoded magnetic resonance signals, or quantities calculated from said spatially encoded signal amplitudes for deviations based on spatial non-linearities in the magnetic field strength of said temporary magnetic gradient fields, utilizing correction means, to produce corrected magnetic resonance signals".

Liu discloses pre-scan calibration of spatially dependent data errors in single echo sequences. Liu discloses subjecting a number of regions of an object to a calibration pulse sequence, wherein each pulse generates a single calibration echo (col. 5, lines 5-15; Fig. 2A). With respect to correction of amplitude deviations, Liu discloses that an average of all collected calibration echoes is calculated and scaled values of all calibration echoes are used to correct amplitude deviations in all the imaging echoes (col. 5, lines 58-65). The use of scaled values based on an average of all calibration echoes, as disclosed in Liu, does not disclose, teach or suggest "correcting said signal amplitudes of said spatially encoded magnetic resonance signals, or quantities calculated from said spatially encoded signal amplitudes for deviations in the magnetic resonance image based on spatial non-linearities in the magnetic field strength of said

temporary magnetic gradient fields, utilizing correction means, to produce corrected magnetic resonance signals", as recited in independent claims 1, 8, and 9. In contrast, Liu bases the correction on deviation of calibration echoes from an average of the calibration echoes.

Accordingly, independent claims 1, 8, and 9 are not anticipated by Liu under 35 U.S.C. §102. Furthermore, Liu fails to teach or suggest that a correction is made based on a spatial non-linearity of the magnetic fields of the gradient coils. Instead, Liu bases the correction on a deviation of each calibration echo from an average of all calibration echoes. Accordingly, independent claims 1, 8, and 9 are also allowable over Liu under 35 U.S.C. §103.

McKinnon fails to teach or suggest what Liu lacks. McKinnon discloses a fast spin echo pulse sequence for diffusion weighted imaging. McKinnon discloses producing a gradient pulse after each RF refocusing pulse in the fast spin echo pulse sequence to rephase the diffusion weighted spin magnetization prior to each NMR echo signal acquisition (see col. 3, lines 32-35). Accordingly, McKinnon is concerned with the phase of the acquired echo signals and does not teach or suggest "correcting said signal amplitudes of said spatially encoded magnetic resonance signals, or quantities calculated from said spatially encoded signal amplitudes for deviations in the magnetic resonance image that are due to spatial non-linearities in the magnetic field strength of said temporary magnetic gradient fields, utilizing correction means, to produce corrected magnetic resonance signals", as recited in independent claims 1, 8, and 9.

In view of the above amendments and remarks, independent claims 1, 8, and 9 are allowable over Liu in view of McKinnon under 35 U.S.C. §103.

Dependent claims 2-7, being dependent on independent claim 1, are deemed allowable for at least the same reasons expressed above with respect to independent claim 1.

Dependent claim 2 is amended to recite that the "step of correcting the signal amplitudes of the magnetic resonance signals includes calculating deviations of actual magnetic gradient field from an ideal gradient field using the geometrical shape of the gradient coils and the time profile of the temporary current pulse through the gradient coils". Support for this amendments is found on page 2, lines 30-32 of the specification. Liu are not fails to teach or suggest calculating deviations of the actual magnetic gradient field from an ideal magnetic field. Rather, Liu merely averages a plurality of calibration echoes and performs a scaling of the echoes based on deviations from the calculated average. This averaging in Liu fails to disclose, teach or suggest that the corrections are based on calculated deviations of the magnetic field gradient of a gradient coil from an ideal gradient, as recited in dependent claim 2. Since Liu calculates errors based on an average of calibration echoes, Liu fails to provide any motivation for basing corrections on calculated deviations of the magnetic field gradient of a gradient coil from an ideal gradient. As noted above, McKinnon relates to rephasing of diffusion weighted spin magnetization and fails to teach or suggest anything about correcting signal amplitudes. Accordingly, dependent claim 2 should be allowable over Liu and McKinnon for at least these additional reasons.

Dependent claim 6 recites "the magnetic resonance imaging method is diffusion-related and a diffusion sensitivity parameter (b) is a quantity calculated from said amplitudes of said magnetic resonance signals, which is corrected for deviations based on spatial non-linearities of the temporary magnetic gradient fields of said gradient coils". As stated above, Liu teaches only a scaled correction of calibration echoes and does not relate to diffusion-related imaging method. McKinnon discloses a fast spin echo pulse sequence for rephrasing a diffusion weighted spin magnetization. However, there is no teaching or suggestion for a diffusion

sensitivity parameter (b) calculated from said amplitudes of said magnetic resonance signals, which are corrected based on spatial non-linearities of the temporary magnetic gradient fields of said gradient coils. Accordingly, dependent claim 6 should be allowable for at least this additional reason.

Dependent claim 7 recites "the magnetic resonance imaging method is flow-related and a flow sensitivity parameter (Q) is a quantity calculated from said amplitudes of said magnetic resonance signals, which is corrected for deviations based on spatial non-linearities of the temporary magnetic gradient fields of said gradient coils". Neither the scaled calibration echoes disclosed by Liu nor the fast spin echo pulse sequence for rephasing a diffusion weighted spin magnetization disclosed by McKinnon discloses a flow sensitivity parameter (Q) calculated from said amplitudes of said magnetic resonance signals, which are corrected based on spatial non-linearities of the temporary magnetic gradient fields of said gradient coils. Accordingly, dependent claim 7 should be allowable for at least this additional reason.

The application is now deemed to be in condition for allowance and early notice to that effect is solicited.

It is believed that no fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 03-2412.

Respectfully submitted,

COHEN, PONTANI, LIEBERMAN & PAVANE

By _____

Alfred W. Froebrich
Reg. No. 38,887
551 Fifth Avenue, Suite 1210
New York, New York 10176
(212) 687-2770

Dated: June 25, 2004